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To: MR. TOM OSTROM, CHIEF
OFFICE OF EARTHQUAKE ENGINEERING

Date: April 7, 2014

File: 07-LA-005-R87.37
0000001016- 6SSCN
Tejon Pass OC
Bridge No. 53-1779

Attention: Mr. Mark Yashinsky

From: DEPARTMENT OF TRANSPORTATION
DIVISION OF ENGINEERING SERVICES
Materials Engineering and Testing Services and Geotechnical Services
Office of Geotechnical Support – Geotechnical Instrumentation

Subject: Evaluation of Fault Rupture Potential, Tejon Pass Overcrossing, Bridge No. 53-1779, Post Mile R87.37, Interstate 5, Los Angeles County, California

SUMMARY

The Tejon Pass Overcrossing is situated within the Alquist-Priolo Earthquake Fault Zones for the historically active San Andreas Fault. Splays of the fault were observed to cross under the bridge, most notably between Abutment 1 and Bent 2. Other splays of the fault were also observed in the adjacent graded road cuts hillsides both west and east of the bridge, as well as under the bridge between Bent 2 and Abutment 3, and under Abutment 3. A fault rupture analysis was performed and a design value of 20.8 feet (6.34 m probabilistic) of lateral displacement was estimated at the bridge. Vertical displacement of approximately 10% the lateral value should be expected. Both the lateral and vertical displacements could have a topographic component that may increase the amount of apparent offset, and should also be anticipated. Ground displacements to the bridge and adjacent hillside slopes due to strong ground shaking must also be considered. **Additional work is recommended if it is determined that the bridge structure cannot accommodate these amounts of displacement.**

INTRODUCTION

This evaluation was prepared as part of the statewide evaluation of fault rupture potential at Caltrans bridges. Caltrans policies regarding fault rupture at bridges are described in Memo to Designers (MTD 20-10, 2013). Caltrans requires a fault rupture evaluation if a bridge is located within an Alquist-Priolo Earthquake Fault Zone (EFZ) or within 1,000 feet of an un-zoned fault 15,000 years or younger in age (MTD 20-10). Tejon Pass OC, Bridge No. 53-1779 (LA-005-R87.37) is located on Interstate 5 at the crest of the Tejon Pass (Figure 1) about 1.55 miles north of Gorman, in Los Angeles County. It is situated within the Alquist-Priolo Earthquake Fault Zone for the San Andreas Fault as depicted on both the Frazier Mountain and adjacent Lebec

Quadrangle maps (Figure 2). Therefore an evaluation of the fault rupture potential for this bridge was required.

The "Golden State Freeway" over the "Holland Summit" area just north of Gorman was improved in the late 1940's and/or early 1950's by excavating a road cut for a 4 lane road with median through the hillsides. In 1965 the roadway for the 4 lanes and median of the current "Interstate 5" was again excavated deeper into the hillsides along the eastern side of the then existing "Golden State Freeway" and the roadway was moved to the new route. The northbound roadway of the older route was removed by the newer grading and the southbound lanes were converted to the Peace Valley Road, a surface street. Later, the Tejon Pass OC bridge was built in 1966 to provide access across the new highway to those properties on the east. Tejon Pass OC bridge was constructed as 34 feet wide, 232 feet long, two (2) span reinforced concrete (RC) box girder (3cells) structure with two (2) RC columns at the bent, and open end diaphragm abutments, all founded on spread foundations (Figure 3). The centerline trend of the bridge is N46°14'13"E and the underlying centerline of Interstate 5 is N43°45'4'W. The bridge is at a right angle (90°) to the road below for no skew.

FAULT RUPTURE EVALUATION

This fault evaluation consisted of:

- Review of selected available existing data
- Review of selected aerial photography and Lidar images
- Field reconnaissance of the site and immediate vicinity

The evaluation reached the following conclusions:

1. The mapped historically active trace of the San Andreas Fault (1857 event) was found to cross under the Tejon Pass OC between Abutment 1 and Bent 2. Other splays of the fault were also located in the graded hillsides both west and east of the bridge, crossing under the bridge between Bent 2 and Abutment 3, and under Abutment 3.

2. The displacement hazard analysis considers potential mapping errors and likelihood that rupture occurs off the observed traces, about 20.8 feet (probabilistic) lateral offset under the bridge should be considered for the design review. Vertical displacement of approximately 10% the lateral value should be expected. Both the lateral and vertical topographic displacements could increase the amount of apparent offset, and should also be anticipated.

3. The road cuts along the western side of the roadway were excavated through the mid and lower portions of several areas of slope instability. This slope instability continues unmitigated to the present day.

REVIEW OF EXISTING DATA

The San Andreas Fault is the principal element in the crustal transform zone system of faults accommodating most of the motion between the North American and Pacific plates. The San Andreas Fault (SAF) is a vertical, dextral, strike slip fault that extends some 685 miles (1100 km) from its offshore intersection with the Mendocino Fracture zone near Punta Gorda on the north, towards to Bombay Beach near the Salton Sea on the southeast. It is divided into ten sections based upon significant bends, steps, and local slip rates along its trend. The subject Tejon Pass OC bridge site is located astride Cholame-Carrizo section of the SAF.

The SAF is a Holocene active fault with numerous paleoseismically documented surface rupture events within the past 15,000 years. The most recent historic (last 200 years) event in the vicinity of the bridge site was the January 9, 1857 Fort Tejon event that ruptured both the Cholame-Carrizo and adjacent Mojave section on the south. The expected maximum magnitude earthquake for the Cholame-Carrizo sections of the SAF is Mw 7.90 (USGS, 2008) and slip rate is 35 mm/yr (Dawson, T., and Weldon, R., 2012).

Fault Evaluation Reports (FERs) have been prepared by the Division of Mines and Geology (predecessor of the California Geological Survey) for the Alquist-Priolo Special Studies Zone (now Earthquake Fault Zone) for the San Andreas Fault depicted on both the Lebec (CGS, 1974) and Frazier Mountain (CGS, 1974) Quadrangle Maps. The general mapped trend of the SAF in the immediate vicinity of the bridge site is N60(±5)°W.

A review of the Log of Test Borings for the Tejon OC bridge (Caltrans 1964) show brecciated rock materials of granitics and volcanics alternating across zones of clay seams which could be considered as evidence of faulting at the site.

REVIEW OF SELECTED AERIAL PHOTOGRAPHY AND LIDAR IMAGES

Selected aerial photographs taken of the Tejon Pass OC area were reviewed (Caltrans, 1957, 1959, and 2000). Additional imagery from Google Earth was also reviewed for the area. Evidence of active faulting within the immediate vicinity of the bridge was observed on all the aerial photos reviewed. Traces of the 1857 faulting event were observed to trend beneath the bridge between Abutment 1 and Bent 2 (Figure 4). Other splays of the fault were also observed in the hillsides and road cuts adjacent to both sides of the bridge site.

Evidence of slope instability (landslides) and areas of slope erosion were also observed on the slopes along the western side of the Tejon Pass OC and Peace Valley Road.

LiDAR topographic image data (Open Topography, 2014) for this area of the Tejon Pass OC was reviewed for this evaluation. Lidar imaging for the SAF in the vicinity of the site provided clearly reveal faulting in the vicinity of the subject bridge site (Figure 5) with active splay shown crossing under the bridge and in the western hillside.

FIELD RECONNAISSANCE

A field reconnaissance was conducted of the bridge site and vicinity on December 7, 2012 and by the team of Martha K. Merriam, CEG then with the Office of Geotechnical Support - Instrumentation Branch and K. Douglas Cook, CEG from the office of Geotechnical Design South - Branch 2. The cut slopes for the roadways adjacent to and under the the Tejon Pass OC were reviewed in an attempt to observe evidence of faulting exposed in road cuts. A fault splay (Figure 6) trending under the bridge between Abutment 1 and Bent 2 was observed in the western road cut between the southbound lanes of the roadway and Peace Valley Road above. Another fault splay was more readily observed in this road cut starting at the roadway 450 feet south of the bridge, could be traced up the slope and across Peace Valley Road to the road cut above, crossing the slope 150 feet west of Abutment 1 (Figure 7). Both of these fault splays could be traced northwest across the upper slope and into the remaining landslide debris on the slope (Figure 8).

Additional faulting associated with the SAF zone was also observed in the road cut slope on the east side of the northbound lanes notably projecting between Bent 2 and Abutment 3. Faulting was also observed under Abutment 3 (Figure 9) and to a lesser extent on the slope above the roadway above the abutment.

Another reconnaissance of the bridge site was conducted on June 5, 2013 to observe the toe of slope road cuts made for the widening project of both the southbound and northbound lanes. Numerous splays of the fault were observed at that time in the freshly excavated cuts. Generally the fault splays approached the roadway from the southeast side of the northbound lanes, traversed the freeway south of the bridge and emerged on the northwest side of the southbound lanes. The faults juxtaposed volcanic, granitic, and sandstone blocks of rock across breccias zones and clay seams. The predominate trend of the SAF in the immediate vicinity of the bridge site is N60(±5)°W with cross faults in all directions.

POTENTIAL FOR FAULT RUPTURE

An initial estimate of potential offset was based on an analysis developed by Division of Research and Innovation in collaboration with Geotechnical Services, using methods presented in Abrahamson (2008), Moss and Ross (2011), and Petersen, et al (2011). Both a deterministic fault displacement analysis (DFDHA) and a probabilistic fault displacement analysis (PFDHA) of 5% in 50 years were performed using magnitude, slip rate (for PFDHA), mapping and base map errors, and likelihood of secondary fault traces. The expected maximum magnitude earthquake for the San Andreas Fault (Cholame-Carrizo) is Mw 7.9 and slip rate is 33 mm/yr.

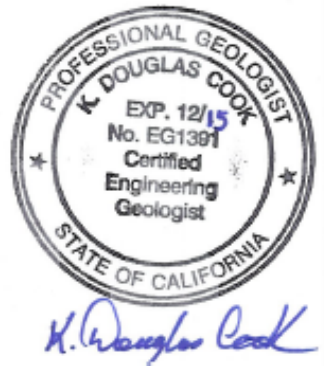
An evaluation of fault displacement as performed per Petersen et al (2011). For this evaluation the trace of the San Andreas fault located under the Tejon Pass OC Bridge was modeled. Since Interstate 5 is situated in a deep road cut that acts as a fault trench at the bridge site beneath the bridge, an assumed weighted 100% of the rupture was used on that splay. Based on that, an evaluation of the potential fault rupture at the Tejon Pass OC bridge is estimated at 20.8 feet (6.34 m) probabilistically (Figure 10) and 20.3 feet (6.18 m) deterministically. However, secondary

shearing and offset will also occur along any of the other numerous fault splays observed within the fault zone.

RECOMMENDATIONS FOR ADDITIONAL INVESTIGATIONS

Additional work is recommended if it is determined that the bridge structure cannot accommodate these amounts of displacement**.** If you have any questions, please contact Douglas Cook at (916) 227-4514.

Prepared by: Date: April 7, 2014



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Research and Innovation – Tom Shantz
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Figure 1. Tejon Pass OC is located on Interstate 5 at the crest of the Tejon Pass.

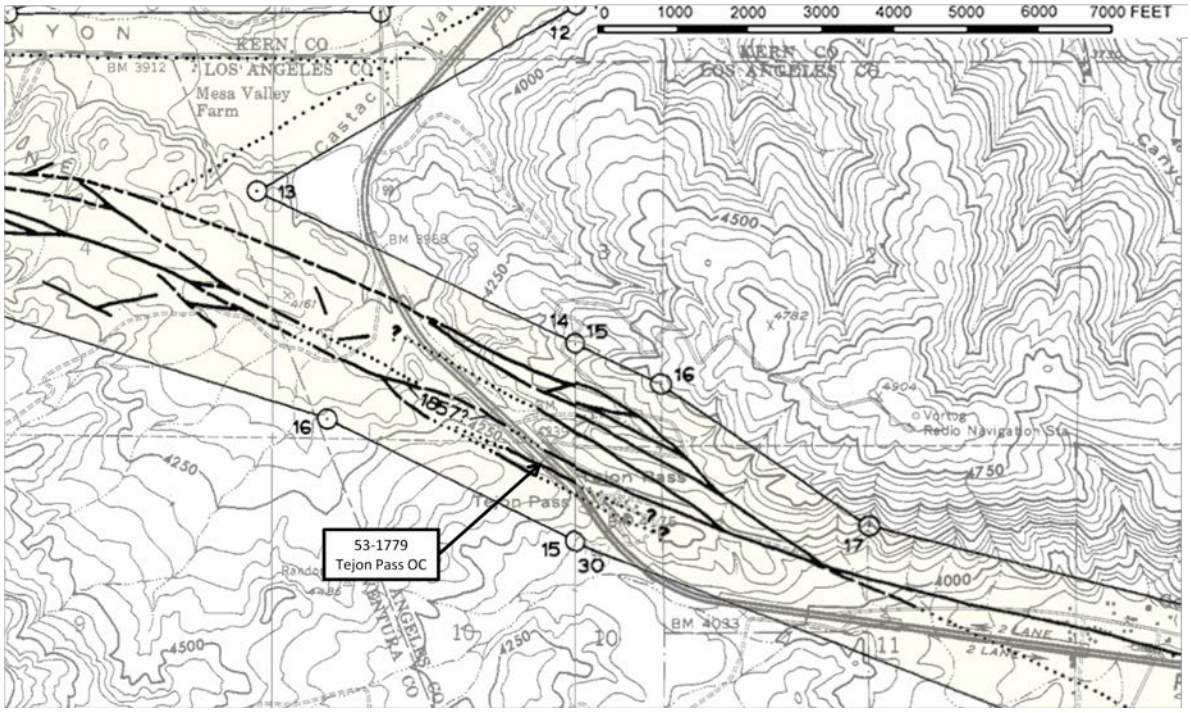

Figure 2. Area fault map, after Frazier Mtn. (Left) and Lebec (Right) Quadrangle Earthquake Fault Zone Maps (CGS, 1974).

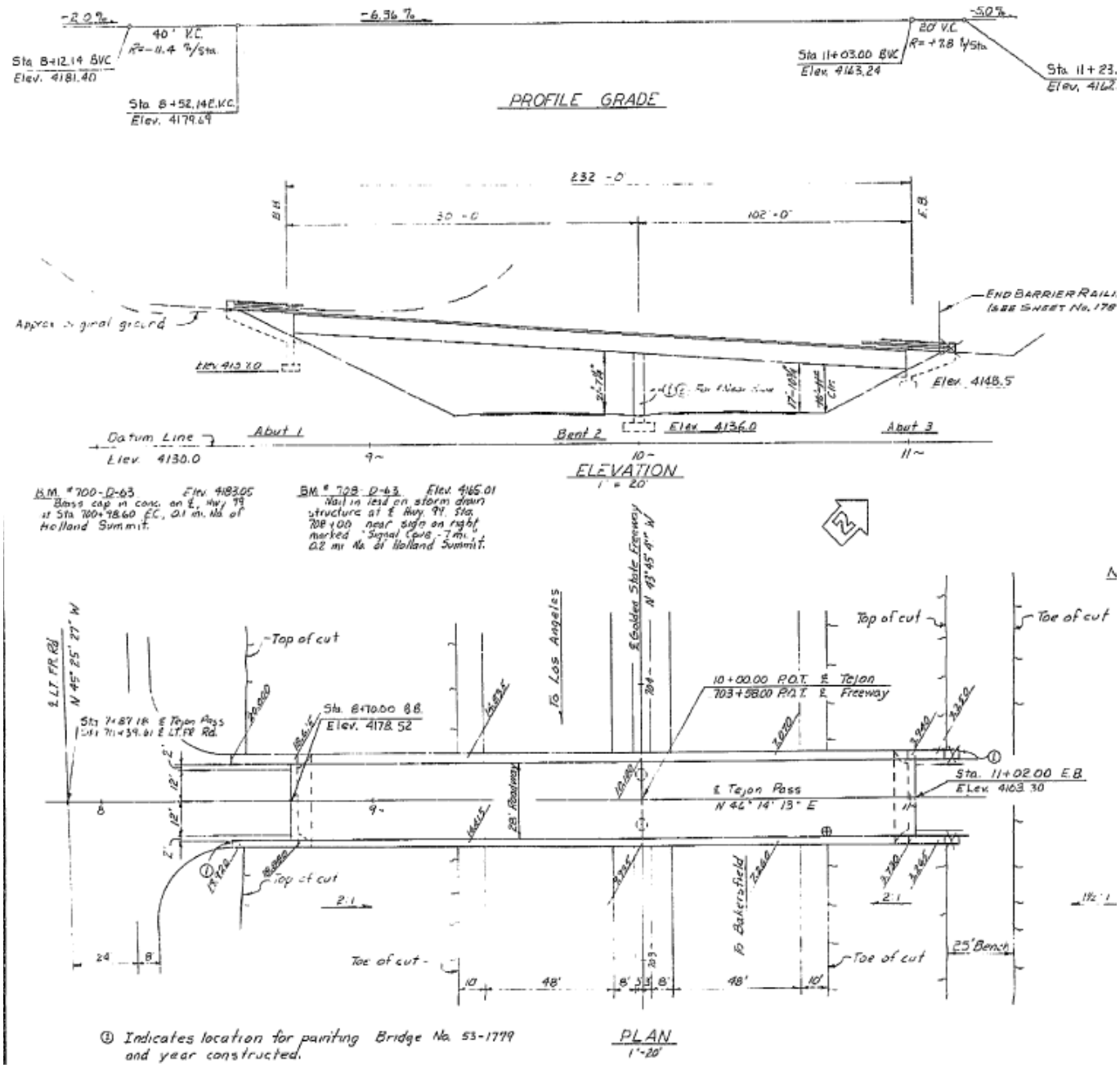

Figure 3: Tejon Pass OC, After As-Built General Plans, 1966.

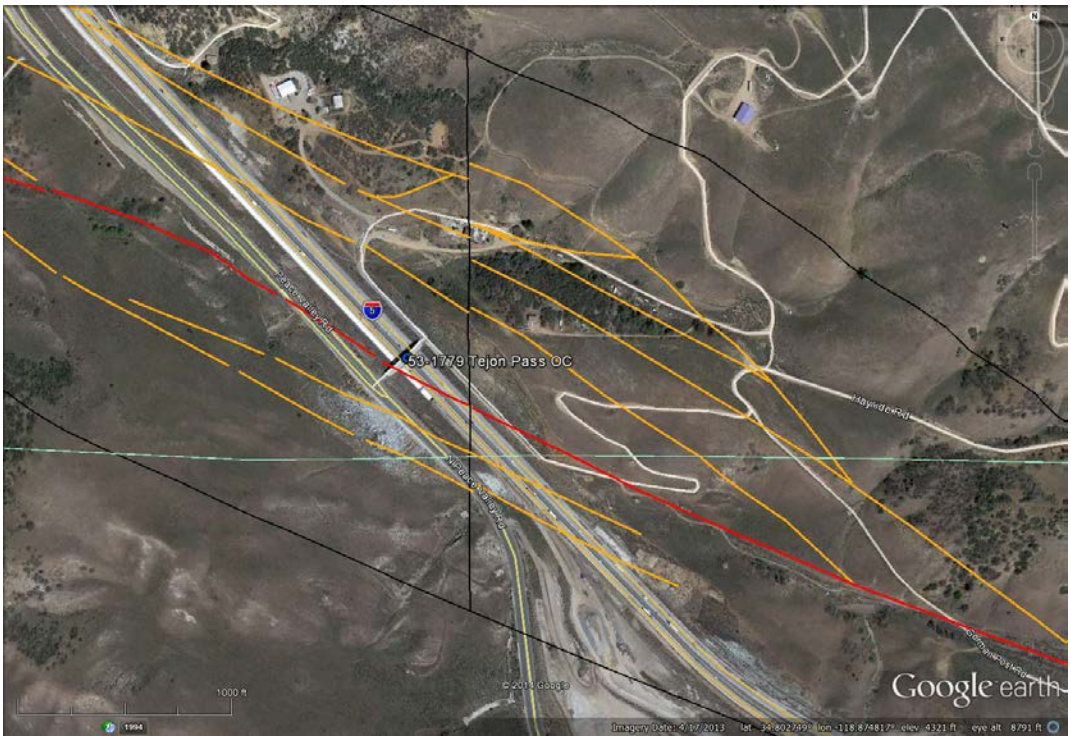

Figure 4. Tejon Pass OC lies over the 1857 break (Red) in the San Andreas Fault Zone,

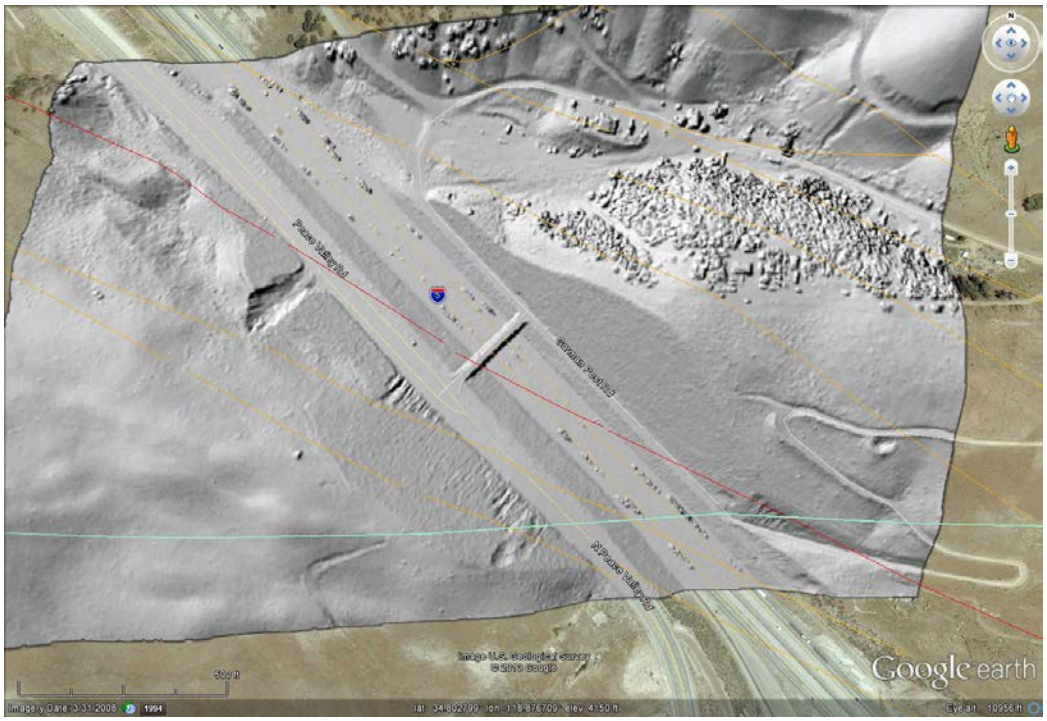

Figure 5. LIDAR Image overlay of Tejon Pass OC Bridge and vicinity. The 1857 fault splay is shown in red.

Figure 6. Close up of fault splay under bridge between Abutment 1 and Bent 2.

Figure 7. Faults crossing under the bridge between Abutment 1 and Bent 2, across the slope south of the bridge extending across the upper slope west of Abutment 1, and slope instability above the western slope.

Figure 8. Slope instability adjacent to and above Abutment 1.

Figure 9. Faulting within the San Andreas Fault Zone under Abutment 3

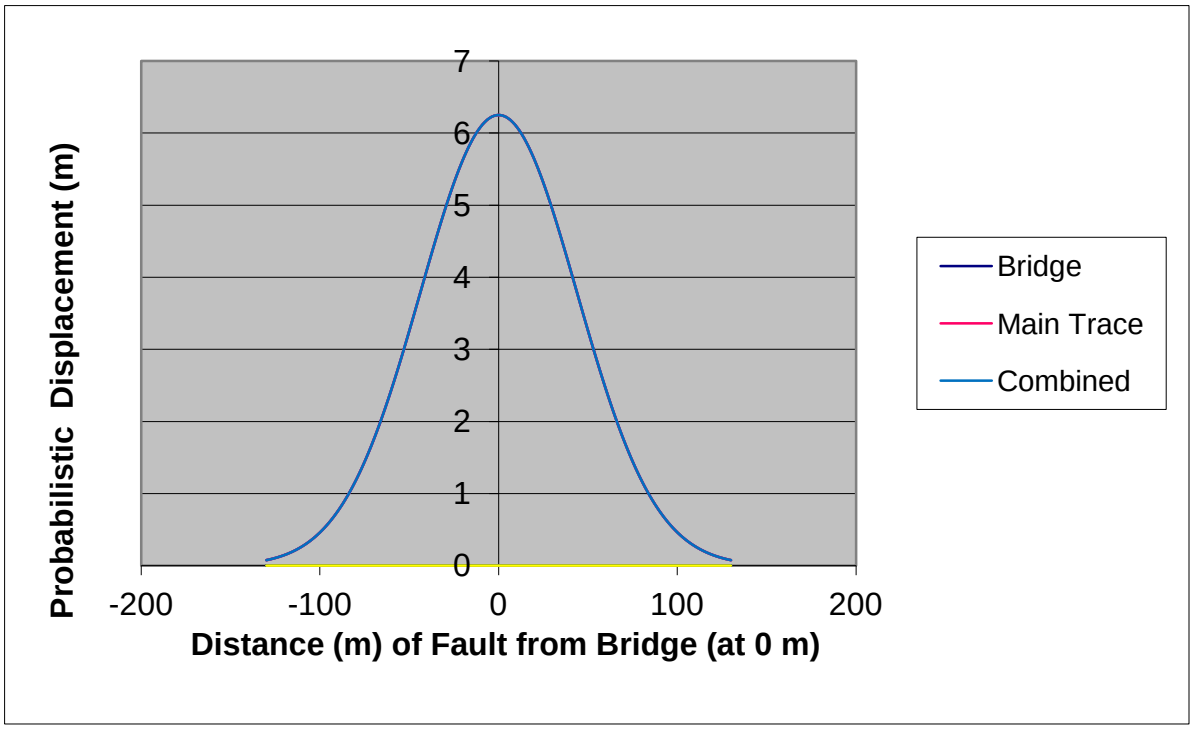

Figure 10. 20.8 feet (6.34m) of probabilistic displacement at Tejon Pass OC bridge (assumed 100%).